# Chinook and Coho Salmon Escapement in the Chena, Delta Clearwater, Goodpaster, and Salcha Rivers, 2010

by

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Symbols and Abbreviations

The following symbols and abbreviations, and others approved for the Système International d'Unités (SI), are used without definition in the following reports by the Divisions of Sport Fish and of Commercial Fisheries: Fishery Manuscripts, Fishery Data Series Reports, Fishery Management Reports, and Special Publications. All others, including deviations from definitions listed below, are noted in the text at first mention, as well as in the titles or footnotes of tables, and in figure or figure captions.

Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
milliliter	mL
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
nautical mile	nmi
ounce	oz
pound	lb
quart	qt
yard	yd

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
degrees kelvin	K
hour	h
minute	min
second	s

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity (negative log of)	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

Alaska Administrative Code	AAC
all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.
all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.
at	@
compass directions:	
east	E
north	N
south	S
west	W
copyright	©
corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
District of Columbia	D.C.
et alii (and others)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.
Federal Information Code	FIC
id est (that is)	i.e.
latitude or longitude	lat. or long.
monetary symbols (U.S.)	$, ¢
months (tables and figures): first three letters	Jan,...,Dec
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S.C.	United States Code
U.S. state	use two-letter abbreviations (e.g., AK, WA)

Mathematics, statistics

all standard mathematical signs, symbols and abbreviations	
alternate hypothesis	H_A
base of natural logarithm	e
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	$(F, t, \chi^2, etc.)$
confidence interval	CI
correlation coefficient (multiple)	R
correlation coefficient (simple)	r
covariance	cov
degree (angular)	°
degrees of freedom	df
expected value	E
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	$\log_2$, etc.
minute (angular)	'
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
variance	
population	Var
sample	var

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ABSTRACT

In 2010, salmon enumeration projects in the Tanana River drainage were conducted on the Chena, Salcha, Goodpaster, and Delta Clearwater rivers. Chinook salmon *Oncorhynchus tshawytscha* escapements for the Chena, Salcha, and Goodpaster rivers were estimated using tower-count methodology and Coho salmon *O. kisutch* escapement on the Delta Clearwater River was estimated by visual boat survey. The Chena River counting tower (conducted by the Alaska Department of Fish and Game, ADF&G) was in operation from 28 June through 7 August. The estimated escapements during that time were 2,382 (SE=152) Chinook salmon and 7,560 (SE=364) chum salmon *O. keta*. The Salcha River counting tower (conducted by Bering Sea Fishermen's Association, BSFA) was in operation from 1 July through 15 August. The estimated Chinook salmon escapement during that time was 6,135 (SE=170) and the estimated chum salmon escapement was 22,185 (SE=412). The Goodpaster River counting tower (contracted out to Tanana Chiefs Conference, TCC, by BSFA) was in operation from 7 July through 1 August and the estimated Chinook salmon escapement during that time was 1,125 (SE=66). The ADF&G minimum count of coho salmon escapement in the Delta Clearwater River was 5,867. The Chena River did not meet the established escapement goal whereas the Salcha and Delta Clearwater rivers met or exceeded the established escapement goals. The estimated proportion of Chinook salmon females in the Chena River escapement was 0.29 (SE=0.03) and the proportion adjusted for gender-bias was 0.21 (SE=0.05). The estimated proportion of Chinook salmon females in the Salcha River escapement was 0.31 (SE=0.02) and the adjusted estimate was 0.27 (SE=0.06). The dominant Chinook salmon age classes in the Chena River were age 1.3 and 2.2 (54%) for males and 1.3 (48%) and 1.4 (48%) for females. The dominant Chinook salmon age class in the Salcha River was age 1.3 for males (57%) and females (58%).

Key words: Chinook salmon, *Oncorhynchus tshawytscha,* chum salmon, *O. keta*, Chena River, Salcha River, Delta Clearwater River, counting tower, escapement.

INTRODUCTION

The primary purpose of this report is to present findings from salmon escapement enumeration projects in the Tanana River drainage conducted by the Alaska Department of Fish and Game-Sport Fish Division (ADFG-SFD), during 2010. These projects included a counting tower enumeration project on the Chena River to estimate total escapement of Chinook salmon *Oncorhynchus tshawytscha* and partial escapement of chum salmon *O. keta*, and a roving boat survey count to estimate escapement of coho salmon *O. kisutch* on the Delta Clearwater River.

Secondarily, this report presents data summaries and estimates of escapement of Chinook salmon from counting tower projects conducted during 2010 by Bering Sea Fisherman's Association (BSFA) on the Salcha River and by Tanana Chiefs Conference (TCC) on the Goodpaster River. Information from these 2 projects is in this report at the request of BSFA and TCC as a means of archiving the count data and escapement estimates in a publication that is easily accessible by stakeholders and other researchers. Information pertinent to the Salcha and Goodpaster rivers enumeration studies are found in Appendix A.

CHENA RIVER CHINOOK SALMON

The Yukon River drainage is the largest river system in Alaska and contains dozens of rivers and streams that support spawning Chinook salmon. These rivers are spread throughout the drainage with lower basin spawning streams being separated from upper basin streams in Canada by more than 2,000 rkm. The upper basin, primarily Canadian streams, accounts for approximately half the total production of Chinook salmon in the drainage, while streams in the Tanana River drainage account for approximately one quarter of the total production (Eiler et al. 2004, 2006a, 2006b). Within the Tanana River drainage, the largest spawning populations return to the Salcha, Chena, Goodpaster, Kantishna, Chatanika, and Nenana rivers.

Commercial, subsistence, sport, and personal use fishing occurs throughout the Alaskan portion of the Yukon River in each of 6 districts, and these fisheries harvest a mixture of spawning stocks. Total annual utilization of Chinook salmon in the Yukon River drainage (including Canadian fisheries) has exceeded 200,000 fish in past years, but recent (2004–2008) annual harvests have averaged approximately 95,000 fish (JTC 2009). Participation and harvest in sport fisheries is low in

most of the Yukon River drainage with the exception of the Tanana River drainage where popular sport fisheries occur in the lower 3 rkm of the Salcha River and in the lower 72 rkm of the Chena River. The 5-yr (2005–2009) average sport catch of Chinook salmon in the Chena River was 898 fish and the average sport harvest was 193 fish (Jennings et al. 2009a, 2009b, 2010a, 2010b, *in prep*). The recent 5-yr (2005–2009) average sport catch of Chinook salmon in the Salcha River was 837 fish and the average sport harvest was 322 fish (Jennings et al. 2009a, 2009b, 2010a, 2010b, *in prep*). There was no reported catch or harvest of Chinook salmon in the Goodpaster River from 2005–2008. In 2009, the sport catch of Chinook salmon in the Goodpaster River was 104 fish and the corresponding harvest was zero (Jennings et al. 2009a, 2009b, 2010a, 2010b, *in prep*). The 5-yr (2005–2009) average sport catch of coho salmon in the Delta Clearwater River was 3,100 fish, and the corresponding average harvest was 266 fish (Jennings et al. 2009a-b, 2010a-b, 2011a-b).

Management of Yukon River Chinook salmon is facilitated by a variety of run assessment projects spread across the drainage that are conducted by a number of agencies. Managers are reliant inseason on a variety of inriver run assessments operated by Alaska Department of Fish and Game-Commercial Fisheries Division (ADFG-CFD) including test fisheries near the mouth of the Yukon River, at the Rapids in the middle River near Rampart, and in the Tanana River near Nenana. Run strength assessments also come from subsistence and commercial fishery catch data, a sonar enumeration project at Pilot Station in the lower river, and a sonar enumeration project near Eagle in the upper river near the Alaska-Canada border. Spawning escapement monitoring projects are conducted by the U.S. Fish and Wildlife Service in the Andreafsky River and Gisasa River, by TCC in Henshaw Creek and Goodpaster River, by BSFA in the Salcha River, and by ADFG-SFD in the Chena River. Escapement monitoring projects have been conducted annually on the Chena, Salcha, and Goodpaster rivers since 1986, 1987, and 2004, respectively.

In 2001, the Alaska Board of Fisheries (BOF) directed ADF&G to establish escapement goals for all actively managed stocks for which adequate data exist. Biological escapement goals

(BEGs) of 2,800–5,700 Chinook salmon in the Chena River and 3,300–6,500 in the Salcha River were established by ADF&G to provide for maximum sustained yield. There are currently no escapement goals for any other Tanana River drainage Chinook salmon stocks.

DELTA CLEARWATER RIVER COHO SALMON

The Delta Clearwater River (DCR) is a spring-fed tributary to the Tanana River located near Delta Junction, about 160 km southeast of Fairbanks (Figure 2). Length of the mainstem is about 32 rkm, the north fork is approximately 10 rkm in length, and there are a number of shallow spring areas adjacent to the main channel.

The DCR has the largest known coho salmon escapements in the Yukon River drainage (Parker 1991). Spawning occurs throughout the main channel and in the spring areas. Before reaching the spawning grounds of the DCR, coho salmon travel about 1,700 rkm from the ocean and pass through several different commercial fishing districts in the Yukon and Tanana rivers. Subsistence or personal use fishing also occurs in each district.

Coho salmon in the DCR support a popular fall sport fishery with a daily bag and possession limit of 3 fish. The average annual harvest exceeded 1,000 coho salmon from 1986–1991. In recent years, catch has been high but harvest has been relatively low (Parker 2006).

Historically, escapements of coho salmon into the DCR have been monitored by counting fish from a drifting riverboat (Parker 1991). From 1994–1998 aerial surveys (using a helicopter) were also conducted to estimate escapement in portions of the river not accessible by boat (Evenson 1995, 1996; Evenson and Stuby 1997; Stuby and Evenson 1998; Stuby 1999-2001). Escapement information is used to evaluate management of the commercial, subsistence, and personal use fisheries, in addition to regulating the sport harvest of coho salmon by opening and closing the season and changing the bag limit. In 2003 the Alaska Board of Fisheries established a sustainable escapement goal (SEG) range of 5,200–17,000 coho salmon for the DCR (measured with boat counts; Parker 2006).
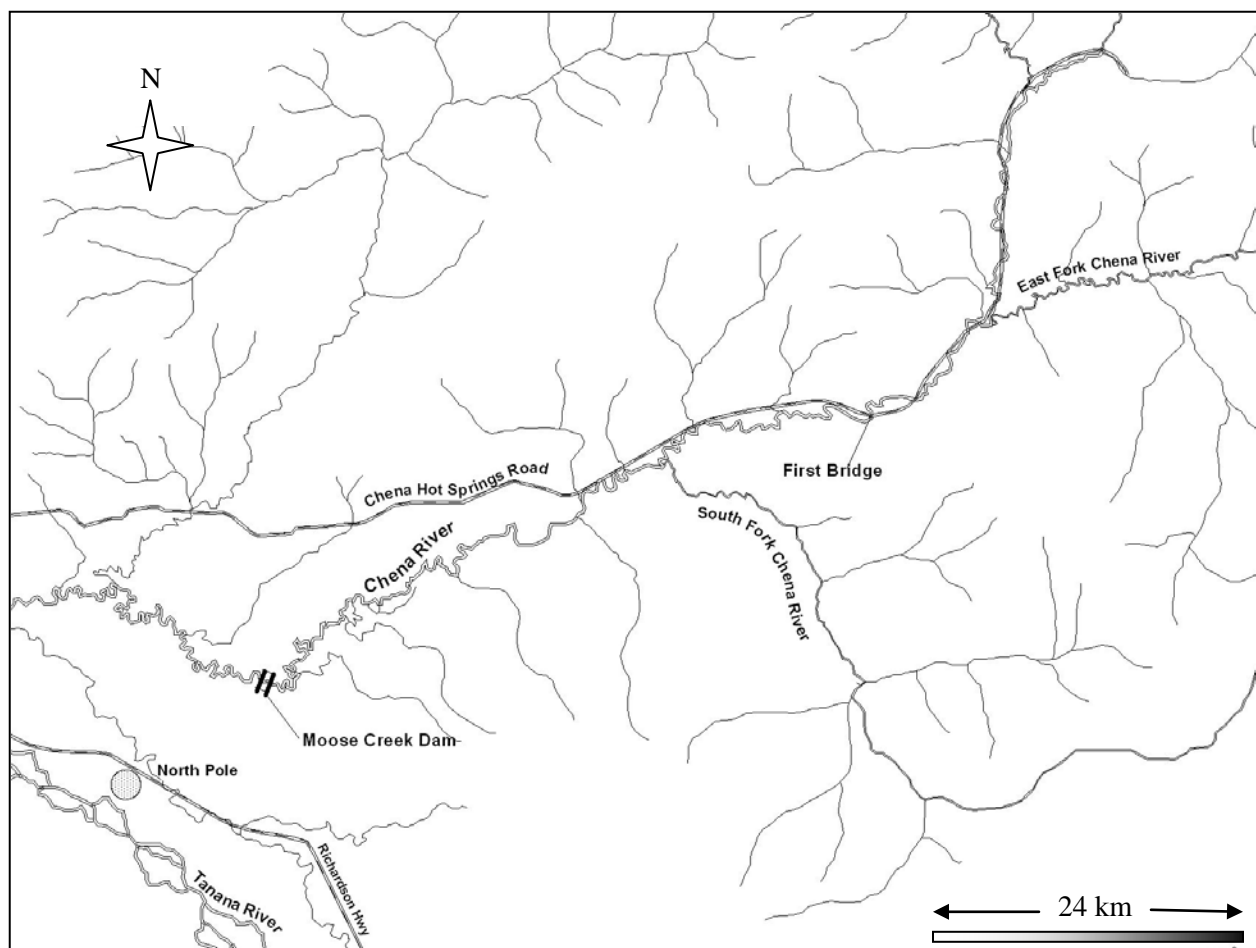
Figure 1.–Map of the Chena River demarcating the Moose Creek Dam and the first bridge on Chena Hot Springs Road.
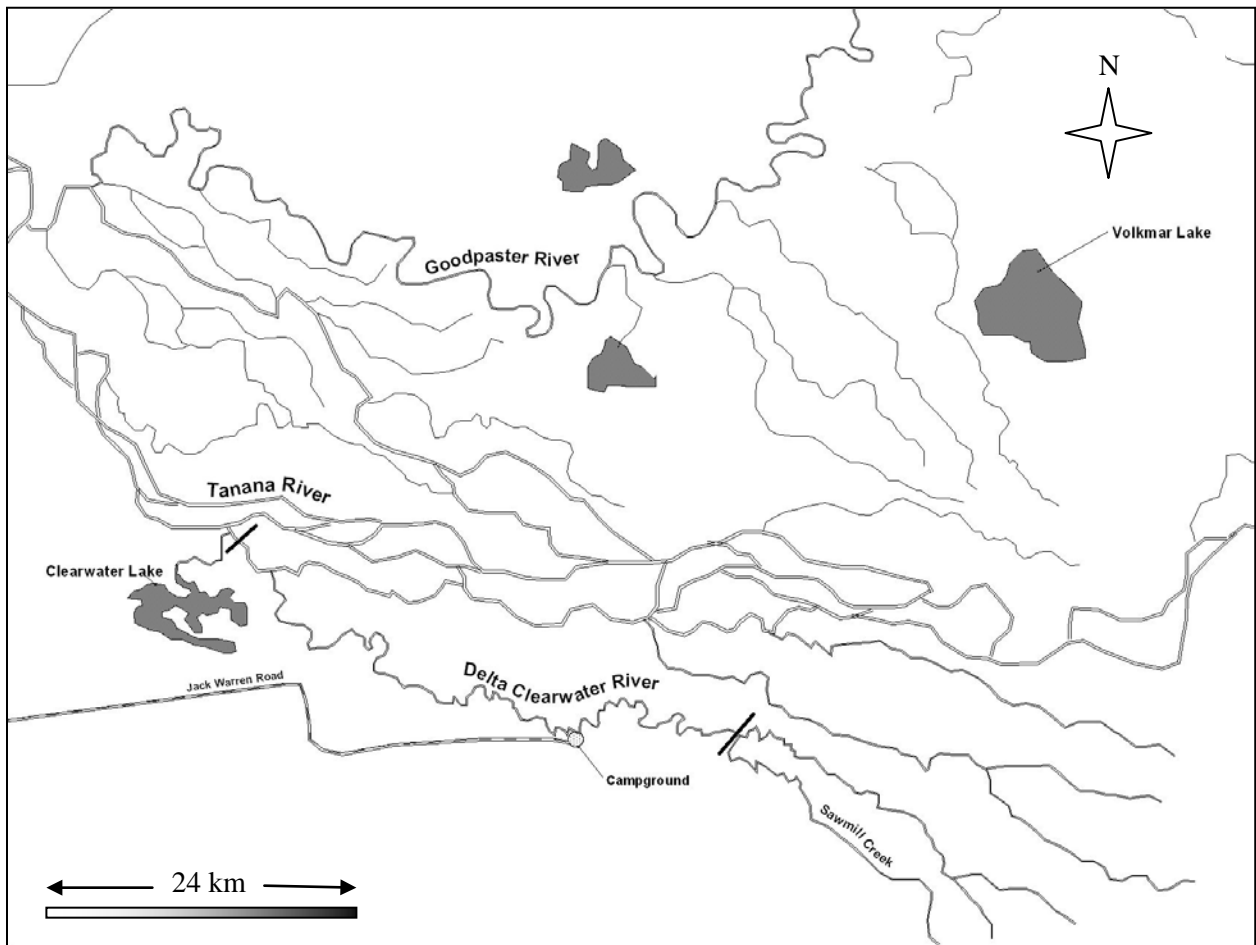
Figure 2.–Map of the Delta Clearwater River demarcating the survey area (bold lines).

OBJECTIVES

The objectives in 2010 were to:

1. estimate the total escapement of Chinook salmon in the Chena River using tower-counting techniques;

2. estimate age and sex compositions of the escapement of Chinook salmon in the Chena River; and,

3. count coho salmon in the Delta Clearwater River to obtain a count of the minimum escapement.

In addition to the objectives there were two tasks:

1. measure the length of carcasses sampled pursuant to Objective 2 to contribute to a database for Arctic-Yukon-Kuskokwim River salmon for general use; and,

2. count chum salmon in the Chena River throughout the duration of the Chinook salmon run.

METHODS

CHENA RIVER CHINOOK SALMON

Daily escapements of Chinook and chum salmon were estimated by visually counting fish from the deck of the Moose Creek Dam as they pass over white fabric panels located on the river bottom on the upstream side of the dam on the Chena River (Figure 1). Lights were suspended over the panels to provide illumination during periods of low ambient light. Counting begins on or about 25 June and continues into August until there are three continuous days with no net upstream passage of Chinook salmon. Virtually all Chinook salmon spawning occurs upstream of this site and no harvest of salmon is allowed upstream of the dam, so final estimates represent the total escapement.

Five technicians were assigned to enumerate the salmon escapement in the Chena River in 2010. Each day was divided into three 8.0-h shifts. Shift I began at 0000 hour (midnight) and ended at 0759 hour; Shift II began at 0800 hour and ended at 1559 hour; Shift III began at 1600 hour and ended at 2359 hour. The start time for all counts began between the top of the hour and 10 min past.

The numbers of Chinook and chum salmon were recorded on field forms at the end of each 20-min count. In addition, the technician would evaluate and record the water clarity conditions (Table 1) as well as the river height from a staff gauge mounted on the dam. Only counts with a rank of 3 or higher were used in the estimate of escapement. A count with a rank of 4 or 5 was considered as no count. Each day, the data sheets from the previous day were returned to the project leader at the end of Shift I.

Dual-frequency Identification Sonar (DIDSON) was used to enumerate migrating fish during periods of high-water (> 2 consecutive days) when tower counts cannot be completed. The sonar units were located ~91 m downstream of the Moose Creek Dam on both sides of the river In 2007, a DIDSON was deployed at this site and a mixture model based on length was used to allocate the total count of salmon passing the sonar into numbers of Chinook and chum salmon. Results were compared to actual tower counts and suggested this methodology is an appropriate means to estimate passage when conditions prohibit tower counts. The objective is to position each sonar so it can record images from each half of the river, 24 hours a day, 7 days a week. Previous tower counts have shown the majority of the Chinook salmon migrate up the north side of the river at the tower site but that is likely due to a deeper channel located on that side of the river. The channel is less pronounced at the sonar site and salmon could migrate up either side of the river. On the north side, the DIDSON was mounted to a 6.7 m aluminum rail that allowed the sonar to be moved up and down the river bank depending on water depth with a pulley mechanism. On the south side, the DIDSON was mounted to a portable aluminum tripod that is moved manually to adjust for water depth. Small weir structures were deployed at each site to ensure migrating salmon pass through the sonar beam.

Table 1.–Water clarity classification.

Rank	Description	Salmon Viewing	Water Condition
1	Excellent	All passing salmon are observable	Virtually no turbidity or glare, "drinking water" clarity; all routes of passage observable
2	Good	All passing salmon are observable	Minimal to moderate levels of turbidity or glare; all routes of passage observable
3	Fair	Possible, but not likely, that some passing salmon may be missed	Moderate to high levels of turbidity or glare; a few likely routes of passage are partially obscured
4.	Poor	Likely that some passing salmon may be missed	Moderate to high levels of turbidity or glare; some-many likely routes of passage are obscured
5	Un-observable	Passing fish are not observable	High level of turbidity or glare; ALL routes of passage obscured

In addition to the tower counts, scales from carcasses of spawned-out Chinook salmon were collected during the first two weeks of August from the dam upriver to the first bridge (Figure 1) to estimate age and sex composition of the escapement. Lengths were also measured. Ages were determined from scale patterns as described by Mosher (1969). Three scales were removed from the left side of the fish approximately two rows above the lateral line along a diagonal line downward from the posterior insertion of the dorsal fin to the anterior insertion of the anal fin (Welander 1940). If no scales were present in the preferred area due to decomposition, scales were removed from the same area on the right side of the fish or if necessary, from any location other than along the lateral line where there are any scales remaining.

Two riverboats with a minimum of 3 people in each boat (1 operator and 2 people collecting carcasses) were used to collect Chinook salmon carcasses. Chinook salmon carcasses were speared from the boats and collected along banks and gravel bars. All deep pools and eddies that could be safely explored were inspected to find and sample as many Chinook salmon carcasses as possible. After collection, the carcasses were placed in a large tub onboard the boat. Once the tub was full, the boat would land on a gravel bar

and the carcasses were laid out in rows of 10 with their left sides facing up. After sampling, all carcasses were cut in a distinctive manner through the left side of the fish to avoid resampling and returned to the river.

DCR COHO SALMON

Previous aerial surveys of the DCR drainage have shown that an average of 20% of the coho escapement is found in areas inaccessible to a boat survey; therefore, counts of adult coho salmon were conducted to obtain a minimum estimate of escapement. This estimate was used to evaluate whether or not the SEG was met.

Two persons (a boat operator and a counter) conducted the survey from a drifting river boat equipped with a 5 ft elevated platform. The survey is typically done during peak spawning times over the course of 1 to 2 days. The survey was conducted along the lower 18 miles of the Delta Clearwater River to within 1.0 mile of the Clearwater Lake outlet (Figure 2). The total number of coho salmon observed (both dead and alive) were recorded every mile at mile markers posted on the river bank. The sum of the section counts equaled the estimate of minimum escapement.

DATA ANALYSIS (CHENA RIVER CHINOOK SALMON)

Estimates of Chinook salmon escapement were stratified by day. Daily estimates of escapement were considered a two-stage direct expansion where the first stage was 8-h shifts within a day and the second stage was counting periods within a shift. The second stage was considered systematic sampling because the counting periods were not chosen randomly.

The formulas necessary to calculate escapement from counting tower data were taken directly or modified from those provided in Cochran (1977). The expanded shift escapement on day d and shift i was calculated by:

$$Y_{di} = \frac{M_{di}}{m_{di}} \sum_{j=1}^{m_{di}} y_{dij} .$$ (1)

The average shift escapement for day d would be:

$$\overline{Y}_d = \frac{\sum_{i=1}^{h_d} Y_{di}}{h_d} .$$ (2)

The following criteria were established to determine the methods used to estimate the daily escapement and its variance:

1. when 2 or more shifts are considered complete, escapement and variance will be estimated using equations 3-8;

2. when counts were only conducted during 1 shift but all 8 counting periods were sampled, escapement will be estimated using equation 3 and variance will be estimated by back-calculating using equation 11; and,

3. when no shifts are considered complete, interpolation techniques described in equations 12 and 13 will be used to estimate escapement and back-calculating using equation 11 will be used to estimate variance.

A minimum of 4 counting periods per shift was required for a complete shift. Counts were conducted during all scheduled counting periods unless water clarity conditions prohibit counts.

The expanded daily escapement was:

$$\hat{N}_d = \overline{Y}_d H_d .$$ (3)

The period sampled was systematic, because a period was sampled every hour in a shift. The sample variance associated with periods would be approximate using the successive difference approach:

$$s_{2di}^2 = \frac{1}{2(m_{di}-1)} \sum_{j=2}^{m_{di}} \left(y_{dij} - y_{di(j-1)}\right)^2 .$$ (4)

Shift sampling was random. The between shift sample variance was calculated as:

$$s_{1d}^2 = \frac{1}{h_d - 1} \sum_{i=1}^{h_d} \left(Y_{di} - \overline{Y}_d\right)^2 .$$ (5)

The variance for the expanded daily escapement was estimated by:

$$\hat{V}\left(\hat{N}_d\right) = \left[\left(1-f_{1d}\right)H_d^2 \frac{s_{1d}^2}{h_d}\right] +$$ (6)

$$\left[\frac{1}{f_{1d}} \sum_{i=1}^{h_d} \left(\left(1-f_{2di}\right)M_{di}^2 \frac{s_{2di}^2}{m_{di}}\right)\right]$$

where:

$$f_{1d} = \frac{h_d}{H_d} ; \text{ and,}$$ (7)

$$f_{2di} = \frac{m_{di}}{M_{di}}$$ (8)

and

d = day;
i = 8-h shift;
j = 20-min counting period;
y_{dij} = the observed 20-min period count;
Y_{di} = expanded shift escapement;
m_{di} = number of 20-min counting periods sampled within a shift;
M_{di} = total number of possible 20-min counting periods within a day (24 would indicate a full day);
h_d = number of 8-h shifts sampled within a day;
H_d = total number of possible 8-h shifts within a day; and,
D = total number of possible days.

Total escapement and variance was estimated by:

$$\hat{N} = \sum_{d=1}^{D} \hat{N}_d \; ; \text{ and,} \qquad (9)$$

$$\hat{V}\left(\hat{N}\right) = \sum_{d=1}^{D} \hat{V}(\hat{N}_d) . \qquad (10)$$

Equation 5, the sample variance across shifts, required data from more than 1 shift per day. In the event that water conditions and/or personnel constraints do not permit at least 2 shifts during a day, a coefficient of variation (CV) was calculated using all days when more than 1 shift was worked. The average CV was used to approximate the daily variation for those days when fewer than 2 shifts were worked. The coefficient of variation was used because it is independent of the magnitude of the estimate and is relatively constant throughout the run (Evenson 1995). The daily CV was calculated as:

$$CV_d = SE_d / \hat{N}_d . \qquad (11)$$

When k consecutive days were not sampled due to adverse viewing conditions, the moving average estimate for the missing day i was calculated as:

$$\hat{N}_i = \frac{\sum_{j=i-k}^{i+k} I(day\,j\ was\ sampled)\hat{N}_j}{\sum_{j=i-k}^{i+k} I(day\ j\ was\ sampled)} \qquad (12)$$

where:

$$I(\cdot) = \begin{cases} 1 & when\,the\,condition\,is\,true \\ 0 & otherwise \end{cases} \qquad (13)$$

is an indicator function. The moving average procedure was only applied to data gaps that do not exceed 2 days (12 consecutive shifts).

Gender bias has been noted when comparing sex ratios of Chinook salmon collected during carcass surveys with those collected by electrofishing (Stuby 2001). Correcting the estimated sex composition estimates from a carcass survey to estimates we might observe in a completely random sample required analysis of data from previous years when mark-recapture experiments were conducted. The adjustment was based on paired electrofishing and carcass survey data from the Chena River (1989–1992, 1995–1997, and 2000). Abundance estimates were generated for each gender and the ratio of the abundance estimate of females to the total abundance was used to generate an unbiased estimate of the proportion of females in the population. A "correction factor" was calculated and applied to the estimated proportion of females in the carcass sample (in years when only carcass samples were collected) based on the average relationship between the proportion estimate from the mark recapture estimates and the proportion estimates from the carcass samples for all 8 years.

The estimated proportions of Chinook salmon males and females from carcass surveys were calculated using (Cochran 1977):

$$\hat{p}_{sc} = \frac{y_{sc}}{n_c} ; \qquad (14)$$

with variance:

$$\hat{V}[\hat{p}_{sc}] = \frac{\hat{p}_{sc}(1 - \hat{p}_{sc})}{n_c - 1} ; \qquad (15)$$

where y_{sc} is the number of salmon of sex s observed during carcass surveys and n_c is the total number of salmon of either sex observed during carcass surveys for $s = m$ or f.

The adjustment necessary to compensate for the gender bias when no electro-fishing was conducted is $\hat{R}_p = 0.708$ with $\hat{V}(\hat{R}_p) = 0.018$.

The bias-adjusted estimate and variance (Goodman 1960) of the proportion of females, $\tilde{p}_{fe}$, is:

$$\tilde{p}_{fe} = \hat{p}_{fc}\hat{R}_p \text{ with variance:}$$
$$\hat{V}(\tilde{p}_{fe}) = \hat{p}_{fc}^2 \hat{V}(\hat{R}_p) + \hat{R}_p^2 \hat{V}(\hat{p}_{fc}) - \qquad (16)$$
$$\hat{V}(\hat{R}_p)\hat{V}(\hat{p}_{fc}) .$$

The estimate and variance of the proportion of males observable during electrofishing are:

$$\tilde{p}_{me} = 1 - \tilde{p}_{fe} \text{ and } \hat{V}(\tilde{p}_{me}) = \hat{V}(\tilde{p}_{fe}) .$$

Escapement of each sex is then estimated by:

$$\hat{N}_s = \tilde{p}_{se}\hat{N} \qquad (17)$$

The variance for $\hat{N}_s$ in this case was (Goodman 1960):

$$\hat{V}(\hat{N}_s) = \hat{V}(\tilde{p}_{se})\hat{N}^2 + \hat{V}(\hat{N})\tilde{p}_{se}^2 - \qquad (18)$$
$$\hat{V}(\tilde{p}_{se})\hat{V}(\hat{N}).$$

Typically, the aging system for salmon includes the number of freshwater and ocean years of residence. For example, age 1.2 symbolizes one year of freshwater residence and 2 years in the ocean, plus 1 year for the year of spawning for a total of 4 years.

The proportion of fish at age k by sex s for samples collected solely for age, sex, and length were calculated as:

$$\hat{p}_{sk} = \frac{y_{sk}}{n_s} \qquad (19)$$

where: $\hat{p}_{sk}$ = the estimated proportion of Chinook salmon that are age k; y_{sk} = the number of Chinook salmon sampled that are age k; and, n_s = the total number of Chinook salmon sampled.

The variance of this proportion was estimated as:

$$\hat{V}[\hat{p}_{sk}] = \frac{\hat{p}_{sk}(1 - \hat{p}_{sk})}{n_s - 1} \qquad (20)$$

Escapement at age k for each sex was then estimated by:

$$\hat{N}_{sk} = \hat{p}_{sk}\hat{N}_s \qquad (21)$$

The variance for $\hat{N}_{sk}$ in this case was (Goodman 1960):

$$\hat{V}(\hat{N}_{sk}) = \hat{V}(\hat{p}_{sk})\hat{N}_s^2 + \hat{V}(\hat{N}_s)\hat{p}_{sk}^2 - \qquad (22)$$
$$\hat{V}(\hat{p}_{sk})\hat{V}(\hat{N}_s).$$

RESULTS

CHENA RIVER CHINOOK SALMON

In 2010, the Chena River counting tower was in operation from 28 June through 7 August. The estimated escapement of Chinook salmon was 2,382 (SE=152) (Table 2), which was not within the established BEG (Table 3, Figure 3). Because tower counts were successfully completed during each day of the run sonar estimates were not required. The estimated chum salmon escapement was 7,560 (SE=364), which was considered a minimum estimate because tower counts were terminated before the chum run was completed (Table 4, Figure 3).

Run timing patterns past the counting tower (Figure 4) were described by the day of the run to facilitate comparison among years (i.e., Day 1 equals the first Chinook salmon passing upriver during a scheduled count). The pattern observed in 2010 was earlier than the average over all years (1997–1999, 2001, 2003-2004, 2006–2009) but similar to the average from the last 3 years (2006–2009).

Carcass surveys began on 3 August and ended on 12 August. A total of 186 Chinook salmon carcasses were sampled for ASL data. Of the 186 carcasses sampled, 105 samples could not be aged.

The sex composition of the escapement was 0.29 (SE=0.03) females and 0.71 (SE=0.03) for males (Table 5). The sex composition adjusted for gender bias was 0.21 (SE=0.05) females and 0.79 (SE=0.05) for males; therefore, the estimated number of females in the escapement adjusted for gender-bias was 490 (SE=113) and the estimated number of males was 1,892 (SE=162).

The age and length composition of the escapement was determined for each sex (Tables 6 and 7). The dominant age classes were age 1.3 and 2.2 (54%) for males and age 1.3 (48%) and age 1.4 (48%) for females.

DCR COHO SALMON

In 2010, the boat survey was conducted on 30 October and the minimum estimate of escapement was 5,867 (Table 8).

Table 2.–Daily estimates of Chena River Chinook salmon escapement, 2010. Shaded cells indicate days estimated using the moving average estimator due to water clarity conditions.

Date	Day of Run	Number 20 Min. Counts	Number Counted	Daily Escapement	Daily SE
30-Jun	0	8	0	0	0.0
1-Jul	0	16	0	0	0.0
2-Jul	0	24	0	0	0.0
3-Jul	0	23	0	0	0.0
4-Jul	0	24	0	0	0.0
5-Jul	0	22	0	0	0.0
6-Jul	1	22	2	8	2.7
7-Jul	2	24	3	9	4.1
8-Jul	3	24	3	9	4.5
9-Jul	4	24	7	21	13.1
10-Jul	5	24	5	15	9.4
11-Jul	6	24	4	12	7.6
12-Jul	7	24	38	114	29.1
13-Jul	8	24	18	54	14.7
14-Jul	9	24	28	84	17.8
15-Jul	10	24	47	141	55.9
16-Jul	11	24	22	66	28.9
17-Jul	12	24	43	129	50.2
18-Jul	13	24	58	174	44.1
19-Jul	14	24	76	228	48.6
20-Jul	15	0	0	186	67.8
21-Jul	16	18	32	143	22.1
22-Jul	17	24	68	204	25.8
23-Jul	18	24	56	168	51.1
24-Jul	19	23	31	101	20.5
25-Jul	20	24	37	111	15.3
26-Jul	21	23	37	112	21.1
27-Jul	22	24	35	105	14.8
28-Jul	23	24	16	48	19.8
29-Jul	24	24	15	45	11.9
30-Jul	25	24	9	27	10.5
31-Jul	26	24	2	6	9.1
1-Aug	27	24	7	21	10.5
2-Aug	28	23	4	11	5.9
3-Aug	29	24	5	15	4.9
4-Aug	30	24	6	18	6.1
5-Aug	31	24	-3	-9	4.5
6-Aug	32	24	2	6	4.1
7-Aug	0	24	0	0	3.2
Total			713	2,382	152.3

Table 3.–Estimates of the Chena River Chinook salmon escapement, 1986–2010.

| Year | Escapement | | Method |
	Estimate	SE	
1986	9,065	1,080	Mark-Recapture
1987	6,404	557	Mark-Recapture
1988	3,346	556	Mark-Recapture
1989	2,730	249	Mark-Recapture
1990	5,603	1,164	Mark-Recapture
1991	3,172	282	Mark-Recapture
1992	5,580	478	Mark-Recapture
1993	12,241	387	Counting Tower
1994	11,877	479	Counting Tower
1995	11,394	1,210	Mark-Recapture
1996	7,153	913	Mark-Recapture
1997	13,390	699	Counting Tower
1998	4,745	503	Counting Tower
1999	6,485	427	Counting Tower
2000	4,694	1,184	Mark-Recapture
2001	9,696	565	Counting Tower
2002	6,967	2,466	Mark-Recapture
2003	11,100[a]	653	Counting Tower
2004	9,645	532	Counting Tower
2005[b]	-[b]	-	-
2006	2,936	163	Counting Tower
2007	3,806	226	Counting Tower
2008	3,208	198	Counting Tower
2009	5,253	231	Counting Tower
2010	2,382	152	Counting Tower

[a] Estimate includes an expansion for missed counting days. SE is a minimum estimate and does not include uncertainty associated with expansion for missed days.

[b] Escapement was not estimated due to multiple flood events.
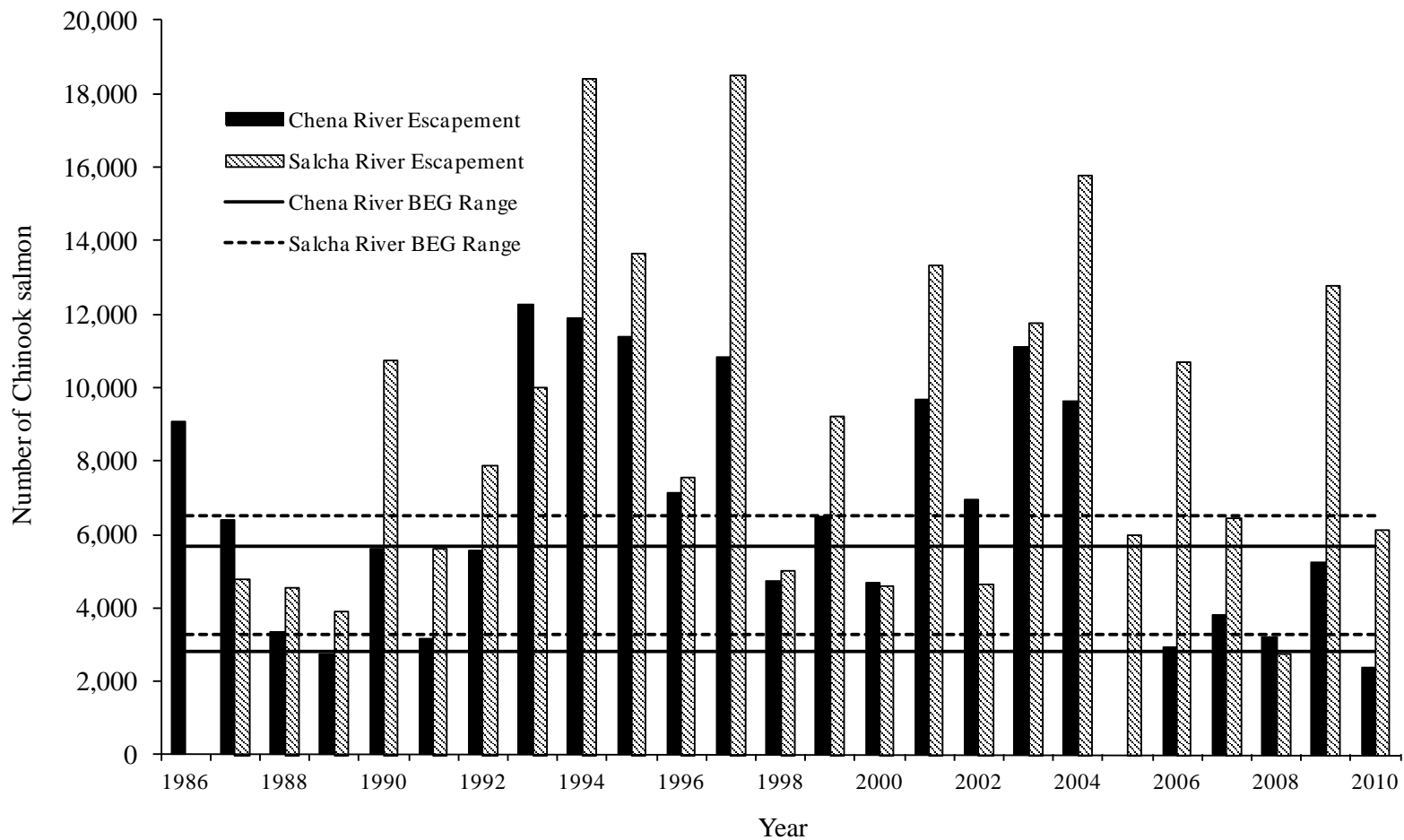
Figure 3.–Estimates of Chinook salmon escapements to the Chena and Salcha rivers and their respective BEG's, 1986–2010.

Table 4.–Daily estimates of Chena River chum salmon escapement, 2010. Shaded cells indicate days estimated using the moving average estimator due to water clarity conditions.

Date	Day of Run	Number of 20 Min. Counts	Number Counted	Daily Escapement	Daily SE
30-Jun	0	8	0	0	0.0
1-Jul	0	16	0	0	0.0
2-Jul	0	24	0	0	0.0
3-Jul	0	24	0	0	0.0
4-Jul	0	24	0	0	0.0
5-Jul	0	22	0	0	0.0
6-Jul	0	22	0	0	0.0
7-Jul	0	24	0	0	0.0
8-Jul	0	24	0	0	0.0
9-Jul	0	24	0	0	0.0
10-Jul	0	24	0	0	0.0
11-Jul	0	24	0	0	0.0
12-Jul	0	24	0	0	0.0
13-Jul	0	24	0	0	0.0
14-Jul	0	24	0	0	0.0
15-Jul	0	24	0	0	0.0
16-Jul	1	24	3	9	5.9
17-Jul	2	24	5	15	6.7
18-Jul	3	24	14	42	10.8
19-Jul	4	24	43	129	28.5
20-Jul	5	0	0	73	17.7
21-Jul	6	18	5	16	7.0
22-Jul	7	24	36	108	36.8
23-Jul	8	24	39	117	37.1
24-Jul	9	24	100	300	59.8
25-Jul	10	24	85	255	39.7
26-Jul	11	23	153	474	120.1
27-Jul	12	24	128	384	42.1
28-Jul	13	24	152	456	81.4
29-Jul	14	24	304	912	175.1
30-Jul	15	24	217	651	86.3
31-Jul	16	24	160	480	63.4
1-Aug	17	24	293	879	126.4
2-Aug	18	23	216	656	130.3
3-Aug	19	24	180	540	105.7
4-Aug	20	24	107	321	78.4
5-Aug	21	24	127	381	73.3
6-Aug	22	24	43	129	25.9
7-Aug	23	24	78	234	42.7
Total			2,488	7,560	363.7
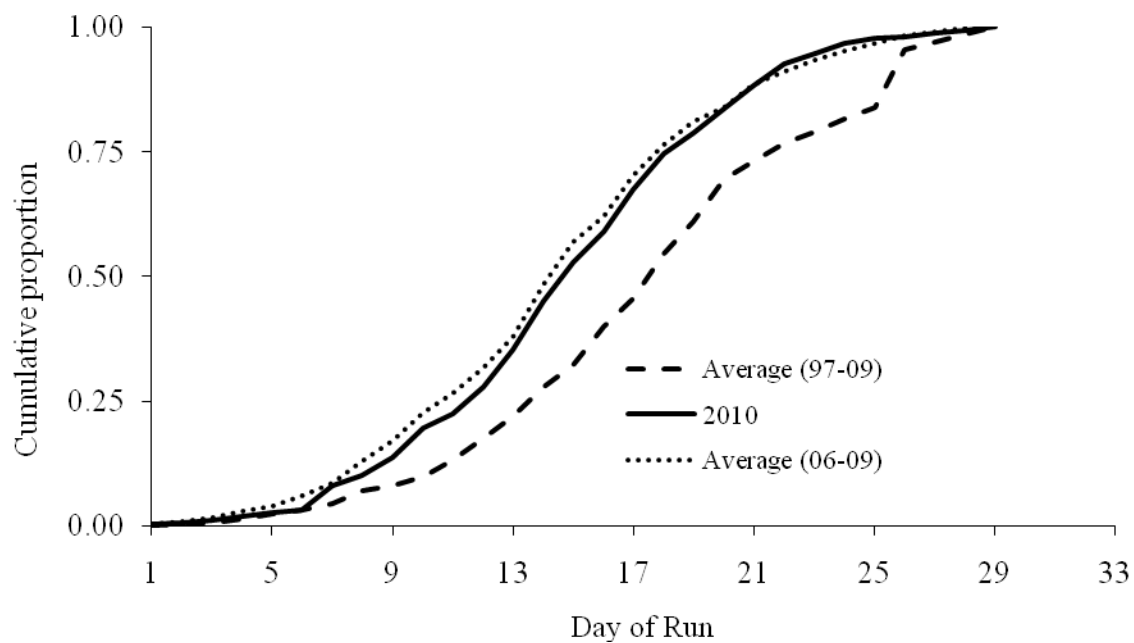
Figure 4.–Run timing pattern for Chena River Chinook salmon past the counting tower in 2010 compared to the average over all years (1997–1999, 2001, 2003–2004, and 2006–2009) and the previous three years (2006–2009).

Table 5.–Estimated proportions of male and female Chinook salmon sampled from carcass surveys on the Chena River, 1986–2010.

	Sexed Sample Size		Sexed Sample Proportion[a]		Sexed and Aged Sample Size		Sexed and Aged Sample Proportion[a]		Adjusted Sample Proportion[b]		Total Escapement	Method[c]
Year	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females		
1986	987	365	0.73	0.27	538	183	0.75	0.25	0.75	0.25	9,065	MR
1987	438	592	0.43	0.57	235	325	0.42	0.58	0.52	0.48	6,404	MR
1988	347	543	0.39	0.61	183	285	0.39	0.61	0.66	0.34	3,346	MR
1989	119	218	0.35	0.65	101	187	0.35	0.65	0.55	0.45	2,730	MR
1990	412	376	0.52	0.48	291	258	0.53	0.47	0.64	0.36	5,603	MR
1991	684	315	0.68	0.32	231	108	0.68	0.32	0.68	0.32	3,172	MR
1992	368	210	0.64	0.36	289	176	0.62	0.38	0.78	0.22	5,580	MR
1993	205	38	0.84	0.16	156	31	0.83	0.17	0.88	0.12	12,241	CT
1994	326	275	0.54	0.46	281	231	0.55	0.45	0.68	0.32	11,877	CT
1995	305	593	0.34	0.66	267	520	0.34	0.66	0.48	0.52	11,394	MR
1996	346	268	0.56	0.44	286	229	0.56	0.44	0.73	0.27	7,153	MR
1997	524	354	0.60	0.40	424	278	0.60	0.40	0.74	0.26	10,810	MR
1998	160	107	0.60	0.40	134	94	0.59	0.41	0.72	0.28	4,745	CT
1999	74	134	0.36	0.64	61	116	0.34	0.66	0.54	0.46	6,485	CT
2000	113	56	0.67	0.33	99	50	0.66	0.34	0.78	0.22	4,694	MR
2001	342	253	0.57	0.43	292	229	0.56	0.44	0.70	0.30	9,696	CT
2002	277	216	0.56	0.44	207	167	0.55	0.45	0.73	0.27	6,967	MR
2003	253	206	0.55	0.45	204	166	0.55	0.45	0.68	0.32	11,100[d]	CT
2004	98	160	0.38	0.62	88	151	0.37	0.63	0.56	0.44	9,645	CT
2005	352	268	0.57	0.43	319	234	0.58	0.42	0.69	0.31	-[e]	-
2006	221	183	0.55	0.45	196	166	0.54	0.46	0.68	0.32	2,936	CT
2007	52	31	0.63	0.37	37	25	0.60	0.40	0.74	0.26	3,806	CT
2008	26	18	0.59	0.41	20	16	0.56	0.44	0.71	0.29	3,208	CT
2009	209	272	0.43	0.57	198	244	0.45	0.55	0.60	0.40	5,253	CT
2010	132	54	0.71	0.29	56	25	0.69	0.31	0.79	0.21	2,382	CT
Average	295	244	0.55	0.45	208	180	0.55	0.45	0.68	0.32	6,575	

[a] Estimated proportions were all derived from carcass samples.

[b] In years when counting tower assessments (CT) were conducted and only carcass surveys were conducted, proportions of males and females were adjusted using the methods shown in Appendix A. In years when mark-recapture experiments (MR) were conducted, proportions of males and females were estimated as the ratio of the abundance estimate of each gender to the abundance estimate of all fish.

[c] Escapement estimates were obtained from either a counting tower (CT) assessment or mark-recapture (MR) project.

[d] Estimate includes an expansion for missed counting days.

[e] Escapement was not estimated due to multiple flood events.

Table 6.–Estimated proportions and mean length by age and sex of Chinook salmon sampled during the Chena River carcass survey, 2010.

Age[a]	Sample Size	Sample Proportion	Length Mean	SE	Min	Max
Males						
1.2	11	0.20	569	9	495	610
1.3	29	0.52	683	17	535	870
2.2	1	0.02	440	-	-	-
1.4	14	0.25	756	31	520	910
1.5	1	0.02	990	-	-	-
Total Aged	56	0.69	676	16	440	990
Total Males[b]	132	0.71	677	11	440	1,010
Adjusted Total[c]		0.79	-	-	-	-
Female						
1.3	12	0.48	809	13	730	870
1.4	12	0.48	821	15	755	945
1.5	1	0.04	805	-	-	-
Total Aged	25	-	814	9	730	945
Total Females[b]	54	0.29	817	6	720	945
Adjusted Total[c]		0.21				

[a] Age is represented by the number of annuli formed during river residence and ocean residence (i.e., an age of 1.4 represents 1 annulus formed during river residence and 4 annuli formed during ocean residence plus 1 year for year of spawning for a total age of 6 years).

[b] Totals include those Chinook salmon which could not be aged.

[c] Estimated proportion of females was corrected by a factor of 0.708.

Table 7.–Age composition and escapement estimates by gender and by all fish combined (unadjusted and adjusted) of Chena River Chinook salmon, 1986–2010.

Males	Total Age (years)/European Age (freshwater years/ocean years)										Male Unadjusted[a]	Male Adjusted[b]
	3	4	5		6		7		8			
Year	1.1	1.2	1.3	2.2	1.4	2.3	1.5	2.4	1.6	2.5	Escapement	Escapement
1986	0.002	0.126	0.636	0.000	0.197	0.019	0.020	0.000	0.000	0.000	6,618	6,764
1987	0.000	0.064	0.281	0.000	0.613	0.009	0.034	0.000	0.000	0.000	2,723	3,320
1988	0.016	0.268	0.355	0.000	0.279	0.000	0.082	0.000	0.000	0.000	1,305	2,212
1989	0.010	0.109	0.495	0.020	0.347	0.010	0.010	0.000	0.000	0.000	964	1,492
1990	0.000	0.423	0.309	0.003	0.254	0.000	0.010	0.000	0.000	0.000	2,970	3,569
1991	0.000	0.126	0.489	0.000	0.312	0.000	0.074	0.000	0.000	0.000	2,161	2,172
1992	0.031	0.682	0.208	0.000	0.080	0.000	0.000	0.000	0.000	0.000	3,468	4,373
1993	0.006	0.353	0.442	0.000	0.192	0.000	0.006	0.000	0.000	0.000	10,327	10,804
1994	0.000	0.053	0.644	0.000	0.292	0.004	0.007	0.000	0.000	0.000	6,442	8,029
1995	0.000	0.131	0.360	0.000	0.491	0.000	0.015	0.004	0.000	0.000	3,870	5,509
1996	0.038	0.108	0.629	0.000	0.136	0.000	0.087	0.000	0.000	0.000	3,972	5,239
1997	0.005	0.611	0.184	0.000	0.196	0.000	0.002	0.002	0.000	0.000	6,529	8,038
1998	0.000	0.075	0.858	0.000	0.045	0.000	0.022	0.000	0.000	0.000	2,843	3,399
1999	0.000	0.115	0.377	0.000	0.508	0.000	0.000	0.000	0.000	0.000	2,338	3,527
2000	0.004	0.386	0.458	0.000	0.149	0.000	0.004	0.000	0.000	0.000	3,139	3,675
2001	0.010	0.154	0.462	0.000	0.353	0.000	0.021	0.000	0.000	0.000	5,573	6,777
2002	0.002	0.422	0.364	0.000	0.206	0.000	0.005	0.000	0.000	0.000	3,915	5,063
2003	0.000	0.088	0.623	0.000	0.240	0.000	0.049	0.000	0.000	0.000	6,118	7,573
2004	0.000	0.295	0.318	0.000	0.364	0.000	0.023	0.000	0.000	0.000	3,664	5,410
2005	0.000	0.110	0.571	0.000	0.292	0.000	0.016	0.013	0.000	0.000	-	-
2006	0.000	0.235	0.592	0.005	0.148	0.005	0.015	0.000	0.000	0.000	1,606	1,994
2007	0.054	0.351	0.297	0.000	0.297	0.000	0.000	0.000	0.000	0.000	2,339	2,767
2008	0.000	0.150	0.750	0.000	0.100	0.000	0.000	0.000	0.000	0.000	1,896	2,279
2009	0.000	0.313	0.293	0.000	0.394	0.000	0.000	0.000	0.000	0.000	2,282	3,150
2010	0.000	0.196	0.518	0.018	0.250	0.000	0.018	0.000	0.000	0.000	1,690	1,892
Average	0.007	0.238	0.461	0.002	0.269	0.002	0.021	0.001	0.000	0.000	3,700	4,947

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Table 7.–Page 2 of 4.

Females	Total Age (years)/European Age (freshwater years/ocean years)										Female Unadjusted[a]	Female Adjusted[b]
	3	4	5		6		7		8			
Year	1.1	1.2	1.3	2.2	1.4	2.3	1.5	2.4	1.6	2.5	Escapement	Escapement
1986	0.000	0.000	0.131	0.000	0.546	0.000	0.311	0.005	0.000	0.005	2,447	2,301
1987	0.000	0.003	0.022	0.000	0.855	0.000	0.114	0.006	0.000	0.000	3,681	3,084
1988	0.000	0.000	0.060	0.000	0.582	0.000	0.351	0.000	0.000	0.007	2,041	1,134
1989	0.000	0.005	0.187	0.000	0.652	0.000	0.155	0.000	0.000	0.000	1,766	1,238
1990	0.000	0.008	0.194	0.000	0.733	0.000	0.066	0.000	0.000	0.000	2,633	2,034
1991	0.000	0.000	0.120	0.000	0.620	0.000	0.231	0.009	0.009	0.009	1,011	1,000
1992	0.000	0.000	0.284	0.000	0.710	0.000	0.006	0.000	0.000	0.000	2,112	1,207
1993	0.000	0.000	0.258	0.000	0.710	0.000	0.032	0.000	0.000	0.000	1,914	1,437
1994	0.000	0.000	0.182	0.000	0.771	0.004	0.043	0.000	0.000	0.000	5,435	3,848
1995	0.000	0.000	0.131	0.000	0.821	0.000	0.044	0.004	0.000	0.000	7,524	5,885
1996	0.000	0.004	0.210	0.000	0.358	0.000	0.428	0.000	0.000	0.000	3,181	1,914
1997	0.000	0.007	0.058	0.000	0.914	0.000	0.022	0.000	0.000	0.000	4,281	2,772
1998	0.000	0.000	0.532	0.000	0.383	0.000	0.085	0.000	0.000	0.000	1,902	1,346
1999	0.000	0.009	0.181	0.000	0.810	0.000	0.000	0.000	0.000	0.000	4,147	2,958
2000	0.000	0.000	0.145	0.000	0.768	0.000	0.087	0.000	0.000	0.000	1,555	1,019
2001	0.000	0.022	0.175	0.000	0.716	0.000	0.087	0.000	0.000	0.000	4,123	2,919
2002	0.000	0.000	0.137	0.000	0.802	0.000	0.061	0.000	0.000	0.000	3,052	1,904
2003	0.000	0.006	0.271	0.000	0.633	0.000	0.090	0.000	0.000	0.000	4,982	3,527
2004	0.000	0.000	0.086	0.000	0.881	0.000	0.033	0.000	0.000	0.000	5,981	4,235
2005	0.000	0.004	0.402	0.000	0.530	0.004	0.043	0.017	0.000	0.000	-	-
2006	0.000	0.000	0.289	0.000	0.705	0.000	0.006	0.000	0.000	0.000	1,330	942
2007	0.000	0.160	0.440	0.000	0.400	0.000	0.000	0.000	0.000	0.000	1,467	1,039
2008	0.000	0.000	0.438	0.000	0.438	0.000	0.125	0.000	0.000	0.000	1,312	929
2009	0.000	0.008	0.070	0.000	0.910	0.000	0.012	0.000	0.000	0.000	2,971	2,103
2010	0.000	0.000	0.480	0.000	0.480	0.000	0.040	0.000	0.000	0.000	692	490
Average	0.000	0.009	0.219	0.000	0.669	0.000	0.099	0.002	0.000	0.001	2,979	2,135

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Table 7.–Page 3 of 4.

Unadjusted[a] All Fish	Total Age (years)/European Age (freshwater years/ocean years)										Total	
	3	4	5		6		7		8			
Year	1.1	1.2	1.3	2.2	1.4	2.3	1.5	2.4	1.6	2.5	Escapement	Method[c]
1986	0.001	0.094	0.508	0.000	0.286	0.014	0.094	0.001	0.000	0.001	9,065	MR
1987	0.000	0.029	0.130	0.000	0.754	0.004	0.080	0.004	0.000	0.000	6,404	MR
1988	0.006	0.105	0.175	0.000	0.464	0.000	0.246	0.000	0.000	0.004	3,346	MR
1989	0.003	0.042	0.295	0.007	0.545	0.003	0.104	0.000	0.000	0.000	2,730	MR
1990	0.000	0.228	0.255	0.002	0.479	0.000	0.036	0.000	0.000	0.000	5,603	MR
1991	0.000	0.086	0.372	0.000	0.410	0.000	0.124	0.003	0.003	0.003	3,172	MR
1992	0.019	0.424	0.234	0.002	0.316	0.002	0.002	0.000	0.000	0.000	5,580	MR
1993	0.005	0.294	0.412	0.000	0.278	0.000	0.011	0.000	0.000	0.000	12,241	CT
1994	0.000	0.029	0.436	0.000	0.508	0.004	0.023	0.000	0.000	0.000	11,877	CT
1995	0.000	0.044	0.208	0.000	0.709	0.000	0.034	0.004	0.000	0.000	11,394	MR
1996	0.021	0.062	0.443	0.000	0.235	0.000	0.239	0.000	0.000	0.000	7,153	MR
1997	0.003	0.372	0.134	0.000	0.480	0.000	0.010	0.001	0.000	0.000	10,810	MR
1998	0.000	0.044	0.724	0.000	0.184	0.000	0.048	0.000	0.000	0.000	4,745	CT
1999	0.000	0.045	0.249	0.000	0.706	0.000	0.000	0.000	0.000	0.000	6,485	CT
2000	0.000	0.201	0.356	0.000	0.356	0.000	0.087	0.000	0.000	0.000	4,694	MR
2001	0.006	0.096	0.336	0.000	0.512	0.000	0.050	0.000	0.000	0.000	9,696	CT
2002	0.000	0.238	0.278	0.000	0.444	0.000	0.040	0.000	0.000	0.000	6,967	MR
2003	0.000	0.051	0.465	0.000	0.416	0.000	0.068	0.000	0.000	0.000	11,100[d]	CT
2004	0.000	0.109	0.172	0.000	0.690	0.000	0.029	0.000	0.000	0.000	9,645	CT
2005	0.000	0.065	0.499	0.000	0.392	0.002	0.027	0.014	0.000	0.000	-[e]	-
2006	0.000	0.127	0.453	0.003	0.403	0.003	0.011	0.000	0.000	0.000	2,936	CT
2007	0.032	0.274	0.355	0.000	0.339	0.000	0.000	0.000	0.000	0.000	3,806	CT
2008	0.000	0.083	0.611	0.000	0.250	0.000	0.056	0.000	0.000	0.000	3,208	CT
2009	0.000	0.145	0.170	0.000	0.679	0.000	0.007	0.000	0.000	0.000	5,253	CT
2010	0.000	0.136	0.506	0.012	0.321	0.000	0.025	0.000	0.000	0.000	2,382	CT
Average	0.004	0.137	0.351	0.001	0.446	0.001	0.058	0.001	0.000	0.000	6,679	

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Table 7.–Page 4 of 4.

Adjusted[b] All Fish Year	Total Age (years)/European Age (freshwater years/ocean years)										Total Escapement	Method[c]
	3	4	5		6		7		8			
	1.1	1.2	1.3	2.2	1.4	2.3	1.5	2.4	1.6	2.5		
1986	0.001	0.094	0.508	0.000	0.286	0.014	0.094	0.001	0.000	0.001	9,065	MR
1987	0.000	0.035	0.156	0.000	0.730	0.004	0.072	0.003	0.000	0.000	6,404	MR
1988	0.011	0.177	0.255	0.000	0.382	0.000	0.173	0.000	0.000	0.002	3,346	MR
1989	0.005	0.062	0.355	0.011	0.485	0.005	0.076	0.000	0.000	0.000	2,730	MR
1990	0.000	0.272	0.267	0.002	0.428	0.000	0.030	0.000	0.000	0.000	5,603	MR
1991	0.000	0.086	0.373	0.000	0.409	0.000	0.123	0.003	0.003	0.003	3,172	MR
1992	0.027	0.574	0.194	0.000	0.204	0.000	0.001	0.000	0.000	0.000	5,580	MR
1993	0.006	0.311	0.421	0.000	0.253	0.000	0.009	0.000	0.000	0.000	12,241	CT
1994	0.000	0.036	0.494	0.000	0.447	0.004	0.019	0.000	0.000	0.000	11,877	CT
1995	0.000	0.063	0.241	0.000	0.661	0.000	0.030	0.004	0.000	0.000	11,394	MR
1996	0.028	0.081	0.517	0.000	0.196	0.000	0.179	0.000	0.000	0.000	7,153	MR
1997	0.004	0.456	0.152	0.000	0.380	0.000	0.007	0.002	0.000	0.000	10,810	MR
1998	0.000	0.053	0.766	0.000	0.141	0.000	0.040	0.000	0.000	0.000	4,745	CT
1999	0.000	0.066	0.288	0.000	0.646	0.000	0.000	0.000	0.000	0.000	6,485	CT
2000	0.003	0.302	0.390	0.000	0.283	0.000	0.022	0.000	0.000	0.000	4,694	MR
2001	0.007	0.114	0.376	0.000	0.462	0.000	0.041	0.000	0.000	0.000	9,696	CT
2002	0.002	0.307	0.302	0.000	0.369	0.000	0.020	0.000	0.000	0.000	6,967	MR
2003	0.000	0.062	0.511	0.000	0.365	0.000	0.062	0.000	0.000	0.000	11,100[d]	CT
2004	0.000	0.166	0.216	0.000	0.591	0.000	0.027	0.000	0.000	0.000	9,645	CT
2005	0.000	0.077	0.519	0.000	0.364	0.001	0.024	0.014	0.000	0.000	-[e]	-
2006	0.000	0.159	0.495	0.003	0.327	0.003	0.012	0.000	0.000	0.000	2,936	CT
2007	0.040	0.301	0.335	0.000	0.324	0.000	0.000	0.000	0.000	0.000	3,806	CT
2008	0.000	0.107	0.659	0.000	0.198	0.000	0.036	0.000	0.000	0.000	3,208	CT
2009	0.000	0.191	0.204	0.000	0.600	0.000	0.005	0.000	0.000	0.000	5,253	CT
2010	0.000	0.156	0.510	0.014	0.297	0.000	0.022	0.000	0.000	0.000	2,382	CT
Average	0.005	0.172	0.380	0.001	0.393	0.001	0.045	0.001	0.000	0.000	6,575	

[a] Unadjusted escapement and composition estimates were derived from the observed sample proportions of males and females from carcass surveys.

[b] Adjusted escapement and composition estimates were derived either from mark-recapture estimates (MR) or in years when counting tower (CT) assessments were conducted, from carcass surveys that were adjusted using the methods described in Appendix A and do not necessarily reflect actual sample proportions.

[c] Escapement estimates were obtained from either a counting tower (CT) assessment or mark-recapture (MR) project.

[d] Estimate includes an expansion for missed counting days. CV is a minimum estimate and does not include uncertainty associated with expansion for missed days.

[e] Escapement was not estimated due to multiple flood events.

Table 8.–Minimum estimates of escapement for Delta Clearwater River coho salmon, 1980–2010.

Year	Survey Date	Minimum Escapement
1980	28 Oct	3,946
1981	21 Oct	8,563
1982	3 Nov	8,365
1983	25 Oct	8,019
1984	6 Nov	11,061
1985	13 Nov	6,842
1986	21 Oct	10,857
1987	27 Oct	22,300
1988	28 Oct	21,600
1989	25 Oct	12,600
1990	26 Oct	8,325
1991	23 Oct	23,900
1992	26 Oct	3,963
1993	21 Oct	10,875
1994	24 Oct	62,675
1995	23 Oct	20,100
1996	29 Oct	14,075
1997	24 Oct	11,525
1998	20 Oct	11,100
1999	28 Oct	10,975
2000	24 Oct	9,225
2001	19 Oct	46,875
2002	31 Oct	38,625
2003	21 Oct	105,850
2004	27 Oct	37,950
2005	25 Oct	34,293
2006	24 Oct	16,748
2007	31 Oct-1 Nov	14,650
2008	30 Oct	7,500
2009	26 Oct	16,850
2010	30 Oct	5,867
Average		20,191

DISCUSSION

To evaluate whether the BEG was met, a precise estimate of escapement was required. In 2010, the majority of the Chena River Chinook salmon run was enumerated under good viewing conditions. These conditions led to a precise estimate of escapement but the estimate and its confidence intervals did not fall within the established BEG (2,382; 95% CI=2,083–2,680).

The sex composition estimates of the 2010 escapement differed from 2009. The adjusted proportion of females (0.21) was the second lowest on record and lower than the 2005–2009 average (0.32). There is typically more males in the Chena River escapement than females and this is likely due to the small sample size, but a trend in this direction would influence future returns.

The age composition estimates of the 2010 escapement were similar to the estimates over all years (1986–2009), with the exception of salmon age 5 (1.3 and 2.2) and age 6 (1.4 and 2.3). However, the proportion of salmon age 5 and 6 tend to complement one another and this relationship is lost when averaging over time. In other words, when there is a large proportion of age 5 salmon in a particular year there is typically a smaller proportion of age 6 salmon and vice versa.

The duration and cumulative proportion of Chena River Chinook salmon past the counting tower was relatively consistent, but a slight trend toward earlier and shorter runs in the most recent years has been displayed. A number of factors such as water flow, temperature, and fishery harvests can influence run timing. In 2010, the overall run timing pattern was earlier than the average over all years, especially during the latter half of the run. However, when compared to the last 3 years (2006–2009) the run timing patterns are nearly identical. In addition, since 1997, the duration of the run has ranged from 29 to 43 d with 50% of the run past the counting tower between days 13 and 25. In contrast, since 2006, the duration of the run has ranged from 29 to 34 d with 50% of the run past the counting tower between days 13 and 16. That is a 64% reduction in the duration and a 75% reduction in the median range of the run. It's likely that this shift in run timing is due to the stock's response to changes over time to their inriver and ocean habitats along with the timing of inriver (Yukon and Tanana drainage) subsistence and commercial fisheries.

The DCR boat count was conducted over 1 day in good conditions which produced a minimum estimate of escapement within the established SEG.

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**APPENDIX A
SALCHA AND GOODPASTER RIVER
CHINOOK SALMON COUNTING TOWERS**

INTRODUCTION

Bering Sea Fishermen's Association (BSFA) began tower counts on the Salcha River in 1999. Further details regarding this project can be obtained by contacting the BSFA.

METHODS

Project mobilization, escapement enumeration, and data analysis procedures for the Salcha River counting tower are virtually identical to those used for the Chena River.

RESULTS

SALCHA RIVER

The Salcha River counting tower (Figure A1) was in operation from 1 July to 15 August; the estimated Chinook salmon escapement during that time was 6,135 fish (SE=170, Tables A1 and A2). The estimated chum salmon escapement during that time was 22,185 fish (SE=412, Table A3).

AGE-SEX-LENGTH COMPOSITIONS

In 2010, a total of 459 Chinook salmon carcasses were collected along the Salcha River from 29 July through 17 August. The estimated proportion of females in the escapement from the carcass survey was 0.31 (SE=0.02) and the gender-bias corrected estimate was 0.27 (SE=0.06). The largest age class for males (57%) and females (58%) was age 1.3 (Tables A4 and A5).

GOODPASTER RIVER

It is unknown what proportion of the Goodpaster River Chinook salmon stock may spawn up the South Fork of the river, but various surveys have shown little if any spawning occurring on the South Fork as habitat is unsuitable for at least the vast majority of the drainage, therefore the estimates of escapements produced by this project should not be considered totally inclusive, but rather representative of the Goodpaster River, until such time as the significance of the South Fork can be ascertained.

The Goodpaster River counting tower (Figure A2) was in operation from 7 July through 1 August; the estimated Chinook salmon escapement during that time was 1,125 (SE=66) (Tables A6 and A7). The Goodpaster River has not been sampled for Chinook salmon ASL composition, although samples have been taken for genetic identification.

data summaries and estimates of escapement of Chinook salmon from counting tower projects by Bering Sea Fisherman's Association (BSFA) on the Salcha River, 2010.
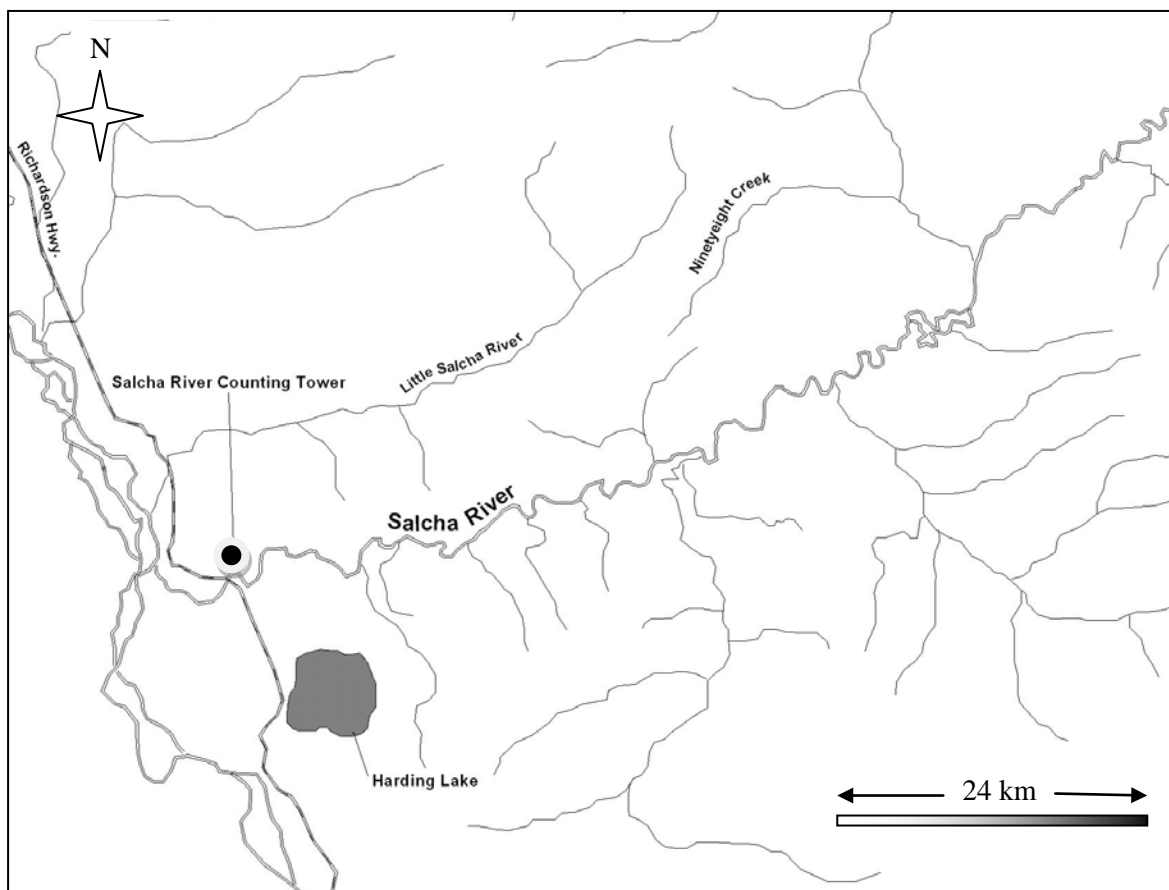
Figure A1.–Map of the Salcha River demarcating the counting tower.

Table A1.–Estimates of the Salcha River Chinook salmon escapement, 1987–2010.

Year	Escapement		Method
	Estimate	SE	
1987	4,771	504	Mark-Recapture
1988	4,322	556	Mark-Recapture
1989	3,294	630	Mark-Recapture
1990	10,728	1,404	Mark-Recapture
1991	5,608	664	Mark-Recapture
1992	7,862	975	Mark-Recapture
1993	10,007	360	Counting Tower
1994	18,399	549	Counting Tower
1995	13,643	471	Counting Tower
1996	7,570	1,238	Mark-Recapture
1997	18,514	1,043	Counting Tower
1998	5,027	331	Counting Tower
1999	9,198	290	Counting Tower
2000	4,595	802	Counting Tower
2001	13,328	2,163	Counting Tower
2002	9,000[a]	160	Counting Tower
2003	15,500[a]	747	Counting Tower
2004	15,761	612	Counting Tower
2005	5,988	163	Counting Tower
2006	10,679	315	Counting Tower
2007	6,425	225	Counting Tower
2008	5,415[a]	169	Counting Tower
2009	12,774	405	Counting Tower
2010	6,135	170	Counting Tower

[a] Estimate was obtained from an expansion of the interrupted tower-count.

Table A2.–Daily estimates of Salcha River Chinook salmon escapement, 2010.

Date	Day of Run	Number 20 Min. Counts	Number Counted	Daily Escapement	Daily SE
9-Jul	1	24	5	15	5.9
10-Jul	2	24	7	21	7.9
11-Jul	3	24	19	57	16.8
12-Jul	4	24	27	81	15.4
13-Jul	5	24	34	102	14.7
14-Jul	6	24	27	81	19.8
15-Jul	7	24	32	96	23.3
16-Jul	8	24	89	267	34.2
17-Jul	9	24	153	459	79.7
18-Jul	10	24	292	876	58.8
19-Jul	11	24	77	231	19.7
20-Jul	12	24	63	189	20.4
21-Jul	13	24	129	387	45.8
22-Jul	14	24	166	498	51.8
23-Jul	15	24	90	270	48.9
24-Jul	16	24	125	375	39.2
25-Jul	17	24	34	102	17.4
26-Jul	18	24	86	258	29.2
27-Jul	19	24	40	120	21.0
28-Jul	20	24	56	168	22.4
29-Jul	21	24	36	108	20.2
30-Jul	22	24	63	189	25.2
31-Jul	23	24	45	135	22.8
1-Aug	24	24	26	78	12.7
2-Aug	25	24	27	81	14.7
3-Aug	26	24	24	72	11.9
4-Aug	27	24	31	93	19.6
5-Aug	28	24	22	66	11.9
6-Aug	29	24	8	24	8.1
7-Aug	30	24	6	18	3.2
8-Aug	31	24	24	72	12.3
9-Aug	32	24	39	117	15.9
10-Aug	33	24	27	81	18.6
11-Aug	34	24	25	75	13.2
12-Aug	35	24	44	132	22.8
13-Aug	36	24	11	33	93.0
14-Aug	37	24	15	45	12.4
15-Aug	38	24	21	63	11.4
Total			2,045	6,135	169.9

Table A3.–Daily estimates of Salcha River chum salmon escapement, 2010.

Date	Day of Run	Number of 20 Min. Counts	Number Counted	Daily Escapement	Daily SE
18-Jul	1	24	6	18	5.9
19-Jul	2	24	10	30	10.5
20-Jul	3	24	12	36	11.3
21-Jul	4	24	26	78	17.3
22-Jul	5	24	82	246	41.7
23-Jul	6	24	69	207	23.3
24-Jul	7	24	50	150	28.4
25-Jul	8	24	77	231	28.3
26-Jul	9	24	157	471	96.4
27-Jul	10	24	163	489	45.1
28-Jul	11	24	262	786	65.4
29-Jul	12	24	403	1,209	83.3
30-Jul	13	24	482	1,446	146.0
31-Jul	14	24	506	1,518	193.7
1-Aug	15	24	511	1,533	113.2
2-Aug	16	24	476	1,428	106.4
3-Aug	17	24	508	1,524	111.0
4-Aug	18	24	516	1,548	67.6
5-Aug	19	24	196	588	47.7
6-Aug	20	24	115	345	44.5
7-Aug	21	24	274	822	61.0
8-Aug	22	24	322	966	65.8
9-Aug	23	24	380	1,140	69.5
10-Aug	24	24	336	1,008	57.9
11-Aug	25	24	244	732	50.4
12-Aug	26	24	219	657	56.8
13-Aug	27	24	327	981	41.4
14-Aug	28	24	222	666	74.5
15-Aug	29	24	444	1,332	96.7
Total			7,395	22,185	412.0

Table A4.–Estimated proportions and mean length by age and sex of Chinook salmon sampled during the Salcha River carcass survey, 2010.

Age[a]	Sample Size	Sample Proportion	Length			
			Mean	SE	Min	Max
Male						
1.1	2	0.01	450	20	430	470
1.2	101	0.35	539	5	440	700
1.3	163	0.57	732	4	550	860
2.2	2	0.01	520	40	480	560
1.4	15	0.05	822	18	735	930
2.3	3	0.01	738	12	720	760
Total Aged	286	0.70	659	7	430	930
Total Males[b]	318	0.69	665	7	375	930
Adjusted Total[c]	-	0.73	-	-	-	-
Female						
1.2	4	0.03	566	43	490	690
1.3	73	0.58	791	5	670	875
1.4	43	0.34	834	8	680	920
1.5	2	0.02	913	18	895	930
2.4	3	0.02	753	23	730	800
Total Aged	125	0.30	800	6	490	930
Total Females[b]	141	0.31	801	6	490	930
Adjusted Total[c]		0.27	-	-	-	-

[a] Age is represented by the number of annuli formed during river residence and ocean residence (i.e., an age of 1.4 represents 1 annulus formed during river residence and 4 annuli formed during ocean residence plus 1 year for year of spawning for a total age of 6 years).

[b] Estimated proportion of females was corrected by a factor of 0.867.

Table A5.–Age composition and escapement estimates by gender and by all fish combined (unadjusted and adjusted) of Salcha River Chinook salmon, 1987–2010.

	Total Age (years)/European Age (freshwater years/ocean years)										Male	Male
Males	3	4	5		6		7		8		Unadjusted[a]	Adjusted[b]
Year	1.1	1.2	1.3	2.2	1.4	2.3	1.5	2.4	1.6	2.5	Escapement	Escapement
1987	0.005	0.152	0.275	0.000	0.544	0.000	0.025	0.000	0.000	0.000	1,766	2,290
1988	0.007	0.333	0.330	0.000	0.243	0.000	0.083	0.003	0.000	0.000	2,223	2,363
1989	0.012	0.107	0.548	0.000	0.333	0.000	0.000	0.000	0.000	0.000	1,477	1,853
1990	0.004	0.333	0.352	0.000	0.268	0.000	0.042	0.000	0.000	0.000	5,832	6,845
1991	0.004	0.143	0.489	0.000	0.309	0.000	0.051	0.000	0.004	0.000	3,082	3,325
1992	0.019	0.543	0.338	0.007	0.084	0.005	0.005	0.000	0.000	0.000	5,020	5,031
1993	0.012	0.384	0.454	0.000	0.146	0.003	0.000	0.000	0.000	0.000	7,364	7,613
1994	0.010	0.035	0.561	0.000	0.366	0.000	0.028	0.000	0.000	0.000	9,825	11,251
1995	0.000	0.296	0.292	0.000	0.388	0.000	0.021	0.004	0.000	0.000	6,013	7,023
1996	0.054	0.118	0.567	0.000	0.177	0.000	0.084	0.000	0.000	0.000	3,777	5,588
1997	0.000	0.256	0.244	0.000	0.489	0.000	0.011	0.000	0.000	0.000	9,597	10,488
1998	0.035	0.070	0.756	0.000	0.128	0.000	0.012	0.000	0.000	0.000	3,532	3,716
1999	0.000	0.201	0.374	0.000	0.424	0.000	0.000	0.000	0.000	0.000	4,471	4,834
2000	0.000	0.304	0.565	0.000	0.130	0.000	0.000	0.000	0.000	0.000	2,776	2,846
2001	0.008	0.167	0.425	0.000	0.400	0.000	0.000	0.000	0.000	0.000	8,395	8,995
2002	0.000	0.554	0.190	0.000	0.179	0.000	0.076	0.000	0.000	0.000	5,907	6,288
2003	0.011	0.126	0.598	0.000	0.241	0.000	0.023	0.000	0.000	0.000	8,964	10,181
2004	0.000	0.247	0.176	0.000	0.576	0.000	0.000	0.000	0.000	0.000	5,910	7,168
2005	0.000	0.204	0.516	0.000	0.265	0.000	0.011	0.004	0.000	0.000	2,709	3,168
2006	0.000	0.101	0.715	0.000	0.174	0.000	0.010	0.000	0.000	0.000	5,989	6,659
2007	0.000	0.343	0.364	0.000	0.293	0.000	0.000	0.000	0.000	0.000	4,130	4,436
2008	0.011	0.163	0.658	0.000	0.168	0.000	0.000	0.000	0.000	0.000	3,307	3,571
2009	0.000	0.520	0.315	0.000	0.165	0.000	0.000	0.000	0.000	0.000	7,774	8,446
2010	0.007	0.352	0.571	0.007	0.052	0.010	0.000	0.000	0.000	0.000	4,250	4,501
Average	0.008	0.252	0.445	0.001	0.273	0.001	0.020	0.000	0.000	0.000	5,171	5,770

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Females	Total Age (years)/European Age (freshwater years/ocean years)										Female Unadjusted[a]	Female Adjusted[b]
	3	4	5		6		7		8			
Year	1.1	1.2	1.3	2.2	1.4	2.3	1.5	2.4	1.6	2.5	Escapement	Escapement
1987	0.000	0.003	0.038	0.000	0.849	0.000	0.110	0.000	0.000	0.000	3,005	2,481
1988	0.000	0.005	0.066	0.000	0.690	0.000	0.239	0.000	0.000	0.000	2,099	1,959
1989	0.000	0.000	0.131	0.000	0.730	0.000	0.139	0.000	0.000	0.000	1,817	1,441
1990	0.000	0.008	0.147	0.000	0.713	0.000	0.132	0.000	0.000	0.000	4,896	3,883
1991	0.000	0.000	0.133	0.000	0.680	0.000	0.183	0.000	0.004	0.000	2,526	2,283
1992	0.000	0.005	0.327	0.000	0.650	0.000	0.014	0.005	0.000	0.000	2,842	2,831
1993	0.000	0.008	0.224	0.000	0.736	0.000	0.032	0.000	0.000	0.000	2,643	2,394
1994	0.000	0.017	0.185	0.000	0.721	0.004	0.073	0.000	0.000	0.000	8,574	7,148
1995	0.000	0.010	0.138	0.000	0.816	0.000	0.030	0.007	0.000	0.000	7,630	6,620
1996	0.000	0.005	0.205	0.000	0.390	0.000	0.400	0.000	0.000	0.000	3,793	1,982
1997	0.000	0.033	0.044	0.000	0.900	0.000	0.022	0.000	0.000	0.000	8,917	8,026
1998	0.000	0.000	0.649	0.000	0.297	0.000	0.054	0.000	0.000	0.000	1,495	1,311
1999	0.000	0.000	0.131	0.000	0.863	0.000	0.006	0.000	0.000	0.000	4,727	4,364
2000	0.000	0.111	0.389	0.000	0.389	0.000	0.111	0.000	0.000	0.000	1,819	1,749
2001	0.000	0.000	0.194	0.000	0.722	0.000	0.083	0.000	0.000	0.000	4,933	4,333
2002	0.000	0.000	0.041	0.000	0.776	0.000	0.184	0.000	0.000	0.000	3,093	2,712
2003	0.000	0.000	0.211	0.000	0.754	0.000	0.035	0.000	0.000	0.000	6,536	5,319
2004	0.000	0.000	0.028	0.000	0.958	0.000	0.014	0.000	0.000	0.000	9,851	8,593
2005	0.000	0.000	0.330	0.000	0.627	0.000	0.043	0.000	0.000	0.000	3,279	2,820
2006	0.000	0.000	0.204	0.000	0.760	0.005	0.032	0.000	0.000	0.000	4,690	4,020
2007	0.000	0.009	0.100	0.000	0.882	0.000	0.009	0.000	0.000	0.000	2,295	1,989
2008	0.000	0.000	0.303	0.000	0.655	0.000	0.042	0.000	0.000	0.000	2,108	1,844
2009	0.000	0.000	0.056	0.000	0.939	0.000	0.006	0.000	0.000	0.000	5,000	4,328
2010	0.000	0.032	0.584	0.000	0.344	0.000	0.016	0.024	0.000	0.000	1,885	1,634
Average	0.000	0.010	0.202	0.000	0.702	0.000	0.084	0.001	0.000	0.000	4,185	3,586

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Table A5.–Page 3 of 4.

Unadjusted[b]	Total Age (years)/European Age (freshwater years/ocean years)											
All Fish	3	4	5		6		7		8		Total	
Year	1.1	1.2	1.3	2.2	1.4	2.3	1.5	2.4	1.6	2.5	Escapement	Method[c]
1987	0.002	0.058	0.126	0.000	0.736	0.000	0.078	0.000	0.000	0.000	4,771	MR
1988	0.004	0.203	0.225	0.000	0.421	0.000	0.145	0.002	0.000	0.000	4,322	MR
1989	0.005	0.041	0.290	0.000	0.579	0.000	0.086	0.000	0.000	0.000	3,294	MR
1990	0.002	0.169	0.249	0.000	0.492	0.000	0.087	0.000	0.000	0.000	10,728	MR
1991	0.002	0.076	0.322	0.000	0.483	0.000	0.113	0.000	0.004	0.000	5,608	MR
1992	0.012	0.361	0.334	0.005	0.276	0.003	0.008	0.002	0.000	0.000	7,862	MR
1993	0.009	0.280	0.391	0.000	0.309	0.002	0.009	0.000	0.000	0.000	10,007	CT
1994	0.006	0.027	0.392	0.000	0.525	0.002	0.048	0.000	0.000	0.000	18,399	CT
1995	0.000	0.136	0.206	0.000	0.628	0.000	0.026	0.006	0.000	0.000	13,643	CT
1996	0.027	0.061	0.383	0.000	0.286	0.000	0.245	0.000	0.000	0.000	7,570	MR
1997	0.000	0.144	0.144	0.000	0.694	0.000	0.017	0.000	0.000	0.000	18,514	CT
1998	0.024	0.049	0.724	0.000	0.179	0.000	0.024	0.000	0.000	0.000	5,027	CT
1999	0.000	0.091	0.241	0.000	0.664	0.000	0.003	0.000	0.000	0.000	9,198	CT
2000	0.000	0.220	0.488	0.000	0.244	0.000	0.049	0.000	0.000	0.000	4,595	CT
2001	0.005	0.104	0.339	0.000	0.521	0.000	0.031	0.000	0.000	0.000	13,328	CT
2002	0.000	0.362	0.138	0.000	0.387	0.000	0.113	0.000	0.000	0.000	9,000	CT
2003	0.007	0.076	0.444	0.000	0.444	0.000	0.028	0.000	0.000	0.000	15,500	CT
2004	0.000	0.092	0.083	0.000	0.817	0.000	0.009	0.000	0.000	0.000	15,761	CT
2005	0.000	0.093	0.415	0.000	0.462	0.000	0.028	0.002	0.000	0.000	5,988	CT
2006	0.000	0.057	0.493	0.000	0.428	0.002	0.020	0.000	0.000	0.000	10,679	CT
2007	0.000	0.224	0.269	0.000	0.503	0.000	0.003	0.000	0.000	0.000	6,425	CT
2008	0.007	0.099	0.518	0.000	0.360	0.000	0.017	0.000	0.000	0.000	5,415	CT
2009	0.000	0.317	0.214	0.000	0.467	0.000	0.002	0.000	0.000	0.000	12,774	CT
2010	0.005	0.255	0.575	0.005	0.141	0.007	0.005	0.007	0.000	0.000	6,135	CT
Average	0.005	0.150	0.333	0.000	0.460	0.001	0.050	0.001	0.000	0.000	9,356	

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Adjusted All Fish	Total Age (years)/European Age (freshwater years/ocean years)											
	3	4	5		6		7		8		Total	
Year	1.1	1.2	1.3	2.2	1.4	2.3	1.5	2.4	1.6	2.5	Escapement	Method[c]
1987	0.002	0.074	0.151	0.000	0.703	0.000	0.069	0.000	0.000	0.000	4,771	MR
1988	0.004	0.185	0.210	0.000	0.446	0.000	0.154	0.002	0.000	0.000	4,322	MR
1989	0.007	0.060	0.366	0.000	0.507	0.000	0.061	0.000	0.000	0.000	3,294	MR
1990	0.002	0.215	0.278	0.000	0.429	0.000	0.075	0.000	0.000	0.000	10,728	MR
1991	0.002	0.085	0.344	0.000	0.460	0.000	0.105	0.000	0.004	0.000	5,608	MR
1992	0.012	0.349	0.334	0.004	0.288	0.003	0.008	0.002	0.000	0.000	7,862	MR
1993	0.009	0.298	0.402	0.000	0.281	0.002	0.007	0.000	0.000	0.000	10,007	CT
1994	0.006	0.028	0.409	0.000	0.509	0.002	0.046	0.000	0.000	0.000	18,399	CT
1995	0.000	0.158	0.217	0.000	0.595	0.000	0.025	0.005	0.000	0.000	13,643	CT
1996	0.040	0.089	0.472	0.000	0.233	0.000	0.167	0.000	0.000	0.000	7,570	MR
1997	0.000	0.163	0.161	0.000	0.661	0.000	0.016	0.000	0.000	0.000	18,514	CT
1998	0.026	0.052	0.728	0.000	0.172	0.000	0.023	0.000	0.000	0.000	5,027	CT
1999	0.000	0.112	0.266	0.000	0.620	0.000	0.003	0.000	0.000	0.000	9,198	CT
2000	0.000	0.238	0.505	0.000	0.219	0.000	0.038	0.000	0.000	0.000	4,595	CT
2001	0.006	0.113	0.351	0.000	0.503	0.000	0.027	0.000	0.000	0.000	13,328	CT
2002	0.000	0.389	0.146	0.000	0.357	0.000	0.108	0.000	0.000	0.000	9,000[d]	CT
2003	0.007	0.080	0.456	0.000	0.429	0.000	0.027	0.000	0.000	0.000	15,500[d]	CT
2004	0.000	0.113	0.096	0.000	0.783	0.000	0.008	0.000	0.000	0.000	15,761	CT
2005	0.000	0.107	0.428	0.000	0.437	0.000	0.026	0.002	0.000	0.000	5,988	CT
2006	0.000	0.062	0.520	0.000	0.397	0.002	0.019	0.000	0.000	0.000	10,679	CT
2007	0.000	0.240	0.282	0.000	0.475	0.000	0.003	0.000	0.000	0.000	6,425	CT
2008	0.007	0.108	0.538	0.000	0.333	0.000	0.014	0.000	0.000	0.000	5,415[d]	CT
2009	0.000	0.343	0.227	0.000	0.427	0.000	0.002	0.000	0.000	0.000	12,774	CT
2010	0.005	0.267	0.575	0.005	0.130	0.008	0.004	0.006	0.000	0.000	6,135	CT
Average	0.006	0.164	0.353	0.000	0.433	0.001	0.043	0.001	0.000	0.000	9,356	

[a] Unadjusted escapement and composition estimates were derived from the observed sample proportions of males and females from carcass surveys.

[b] Adjusted escapement and composition estimates were derived either from mark-recapture estimates (MR) or in years when counting tower (CT) assessments were conducted, from carcass surveys that were adjusted using the methods described in Appendix A and do not necessarily reflect actual sample proportions.

[c] Escapement estimates were obtained from either a counting tower (CT) assessment or mark-recapture (MR) project.

[d] Estimate includes an expansion for missed counting days. SE is a minimum estimate and does not include uncertainty associated with expansion for missed days.

APPENDIX B
GOODPASTER RIVER
CHINOOK SALMON COUNTING TOWER
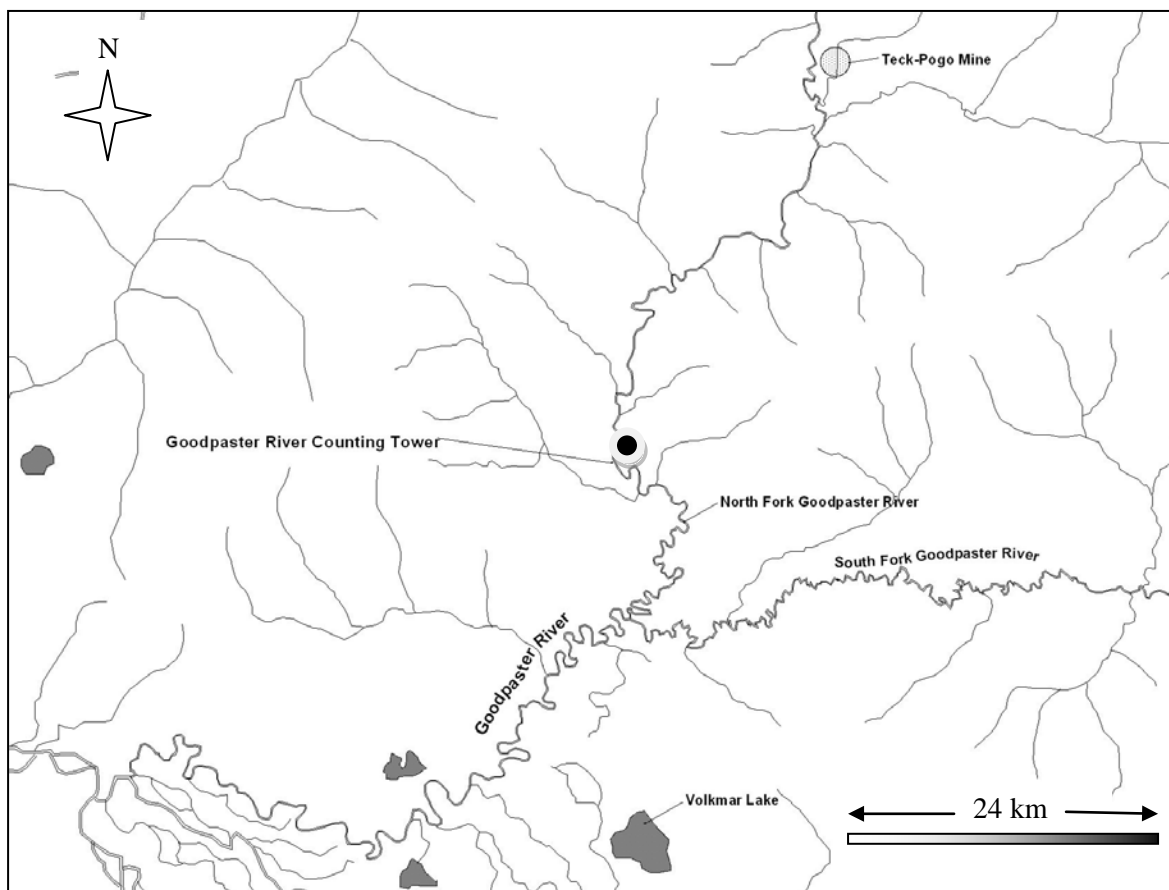
Figure B1–Map of the Goodpaster River demarcating the counting tower.

Table B1.–Estimates of the Goodpaster River Chinook salmon escapement, 2004–2010.

| | Escapement | |
Year	Estimate	SE
2004	3,673	106
2005	1,184	70
2006	2,479	100
2007	1,581	82
2008	1,880	85
2009	4,280	167
2010	1,125	66

Table B2.–Daily estimates of Goodpaster River Chinook salmon escapement, 2010. Shaded cells indicate days estimated using the moving average estimator due to water clarity conditions.

Date	Day of Run	Number 20 Min. Counts	Number Counted	Daily Escapement	Daily SE
7-Jul	0	11	0	0	0.0
8-Jul	0	24	0	0	0.0
9-Jul	0	24	0	0	0.0
10-Jul	0	24	0	0	0.0
11-Jul	1	24	1	3	2.6
12-Jul	2	24	1	3	2.6
13-Jul	3	24	4	12	6.9
14-Jul	4	24	3	9	4.1
15-Jul	5	24	3	9	4.5
16-Jul	6	24	7	21	5.9
17-Jul	7	24	9	27	7.4
18-Jul	8	24	25	75	14.9
19-Jul	9	24	26	78	18.7
20-Jul	10	24	26	78	11.3
21-Jul	11	24	53	159	30.4
22-Jul	12	24	58	174	24.5
23-Jul	13	24	15	45	10.0
24-Jul	14	21	1	3	4.3
25-Jul	15	24	15	45	13.0
26-Jul	16	24	21	63	13.9
27-Jul	17	18	12	36	25.2
28-Jul	18	24	21	63	13.1
29-Jul	19	24	17	51	14.2
30-Jul	20	24	22	66	12.3
31-Jul	21	24	21	63	12.1
1-Aug	22	24	14	42	11.1
Total			375	1,125	65.7